Ecosystem Indicators and the Next OCNMS Condition Report

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Background

- State law on Marine Spatial Planning (March 2010)
  - develop marine management plan for state's marine waters
  - "plan must include an ecosystem assessment … to identify key threats to plan goals, analyze risk and management scenarios, and develop key ecosystem indicators."
- OCNMS AC Science Work Group (September 2014)
  - identified indicators and metrics for Condition Report questions
- MSP Report "Ecological Indicators for Washington State's Outer Coastal Waters" (June 2015)

Ecosystem Indicators

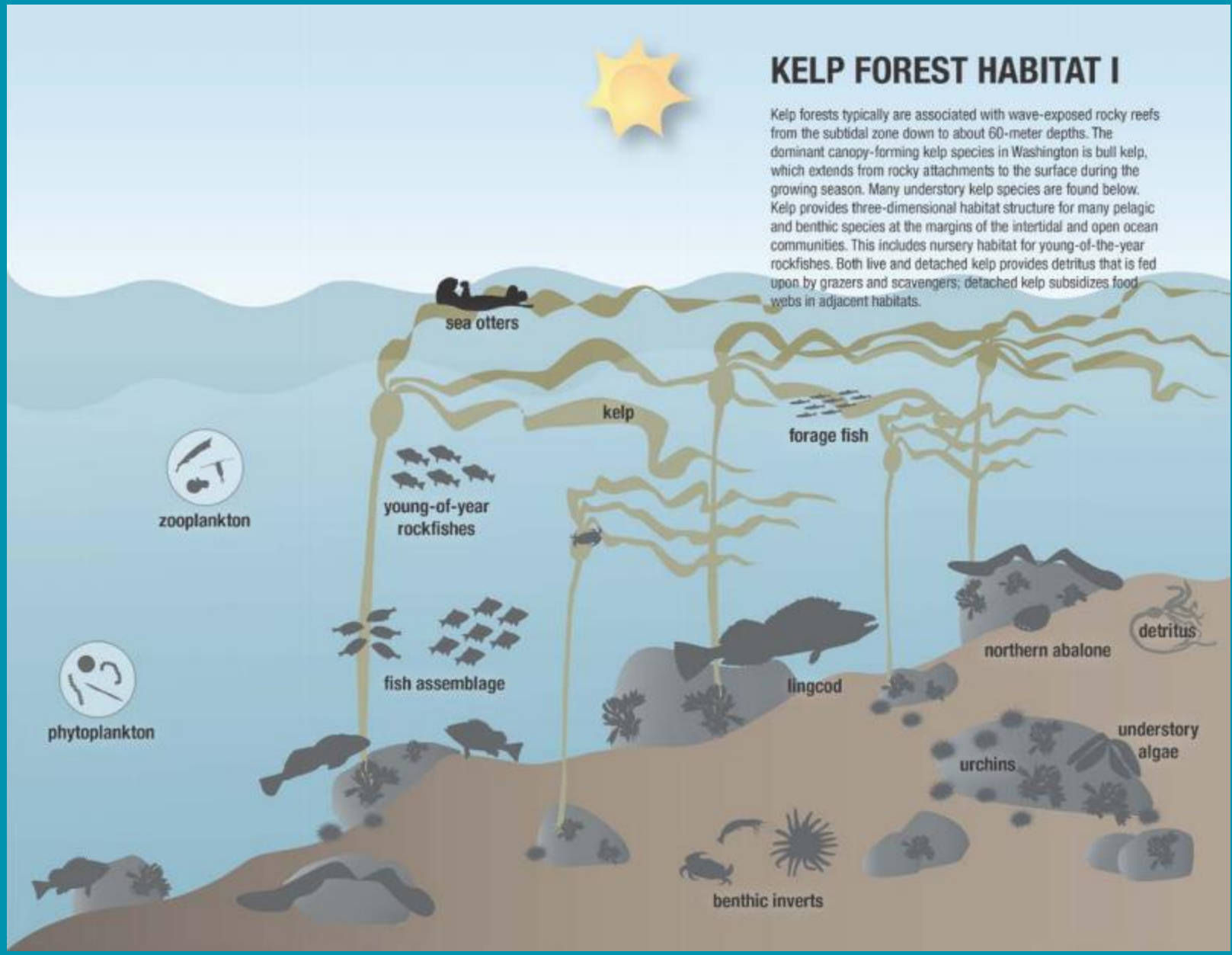
"Ecosystem indicators are quantitative biological, chemical, physical, social, or economic measurements that serve as proxies for the conditions of attributes of natural and socioeconomic systems (Landres et al. 1988, Kurtz et al. 2001, EPA 2008, Fleishman and Murphy 2009)"

- MSP Report

Scope of State Report

- WA-MSP waters = waters and habitats to be included within Washington's marine spatial planning boundary, including waters and habitats ***beyond*** the 3-mile state territorial sea boundary
- Identified 6 habitat types:

1. Coastal estuaries
2. Rock Shores
3. Sandy Beaches
4. Kelp forests
5. Seafloor
6. Pelagic zone


KELP FOREST HABITAT I
Kelp forests typically are associated with wave-exposed rocky reefs from the subtidal zone down to about 60-meter depths. The dominant canopy-forming kelp species in Washington is bull kelp, which extends from rocky attachments to the surface during the growing season. Many understory kelp species are found below. Kelp provides three-dimensional habitat structure for many pelagic and benthic species at the margins of the intertidal and open ocean communities. This includes nursery habitat for young-of-the-year rockfishes. Both live and detached kelp provides detritus that is fed upon by grazers and scavengers; detached kelp subsidizes food webs in adjacent habitats.
sea otters
kelp
forage fish
zooplankton
young-of-year rockfishes
fish assemblage
phytoplankton
lingcod
northern abalone
detritus
understory algae
urchins
benthic inverts

State Report Results

- Identified 110 indicators, each evaluated based on:
  - Established evaluation criteria
  - Weightings generated by resource managers, policy analysts, and scientists
    (How important is each evaluation criteria?)
- Assessed status and trends of selected indicators

Pelagic Habitat Indicators – 1/3

Component	Attribute	Indicator	Time period of available data
Physical drivers			
Climatic	Water temperature	Sea surface temperature	2006 – 2012
		Pacific Decadal Oscillation	1900 – 2015
	El Niño events	Multivariate El Niño Index	1950 – 2015
		Northern Oscillation Index	1948 – 2014
	Source waters	North Pacific Gyre Oscillation index	1950 – 2015
		Northern copepod anomaly	1996 – 2015
Oceanographic	Upwelling	Upwelling index	1967 – 2014
		Spring transition index	1967 – 2015
	Currents, eddies, plumes	Columbia River plume volume	1999 – 2014
	Ocean acidification	pCO2	2006 - 2015
		Aragonite saturation	1998 - 2014
Habitat			
Physical habitat	Quantity	Thermocline depth	1998 - 2014
		Pycnocline depth	1998 - 2014
	Quality	Nitrogen: phosphorus ratio	1998 – 2014
		Sea surface temperature	2006 – 2012

Pelagic Habitat Indicators – 2/3

Component	Attribute	Indicator	Time period of available data
Ecological components			
Phytoplankton	Population size	Chlorophyll-a quantities	2003 – 2014
	Population condition	Diatom: dinoflagellate ratio	NA†
Zooplankton	Population size	Prey field index	1999 - 2014
	Population condition	Northern copepod anomaly	1996 - 2015
Forage fish	Population size	Aggregate abundance	1999 - 2011
	Population condition	Mean age of Pacific sardines	2001 - 2013
Salmon	Population size	Escapement Juvenile abundance	1977 – 2013 1998 - 2013
	Population condition	Coastal fall Chinook age structure Juvenile Coho body growth	1975 – 2014 2000 - 2014
Pacific hake	Population size	Abundance index	1995 – 2013
	Population condition	Mean age of population	1967 - 2015
		Condition factor (K)	1995 - 2015
Marine mammals	Population size	California sea lion pup production	1997 - 2014
	Population condition	Growth of California sea lion pups	1998 - 2014
Ecosystem health	Biodiversity	Simpson's diversity	NA
		Species richness	NA
	Trophic structure	Mean trophic level	NA
		Gelatinous zooplankton	1998 - 2012

Pelagic Habitat Indicators – 3/3

Component	Attribute	Indicator	Time period of available data
Human activities			
Biological extractions	Fishing	Fisheries landings	1982 – 2014
Land –based activities	Pollution	Atmospheric pollution	1994 – 2014
		Organic pollution	1993 – 2010
		Inorganic pollution	1988 – 2013
		Marine debris	1999 – 2007
Ocean-based activities	Commercial shipping	Volume of disturbed waters	2001 – 2013†
	Ocean-based pollution	Shipping + port volume	2001 – 2013†
	Seafood demand	Seafood consumption	1962– 2013

Approach

Question: where is there alignment between OCNMS Science Working Group metrics and State ecosystem indicators?

- Started with matrix table of suggested metrics/indicators from SWG
- Reviewed state report in detail
- Aligned state indicators with SWG questions and metrics

ONMS Condition Report Ecosystem Questions

1. Eutrophic conditions
2. Risks to human health
3. Climate change and water conditions
4. Other stressors on water quality
5. Integrity of habitats
6. Contaminants
7. Keystone and foundation species
8. Other focal species
9. Non-indigenous species
10. Biodiversity

Condition Report Questions

Not covered by MSP indicators:

- maritime archaeological resources
  - Integrity
  - environmental hazards
- states of influential human drivers

SWG Metrics

Q1: *What is the eutrophic condition of sanctuary waters and how is it changing?*

- Nutrient concentrations
- Algae bloom frequency and intensity
- Chlorophyll content
- Primary productivity rates
- Light penetration/water clarity
- Benthic algae cover

SWG Metrics

Q2: *Do sanctuary waters pose risks to human health and how are they changing?*

- Beach advisories/closures
- Water quality ratings (EPA, State)
- Harmful algal bloom frequency
- Seafood harvest closures
- Seafood contamination/consumption advisories
- Contaminant loading in marine mammals
- Animal diseases transferrable to humans
- Fukushima radiation
- Pollutants in trans-Pacific air

Pelagic Habitat

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Q3 Q3 Q7 Q3 Q1 Q1 Q2 Q7 Q7 Q6

<u>Condition Report Questions & Metrics</u>

Q1: eutrophication

Q2: human health

Q3: climate change and water conditions

Q6: contaminants

Q7: keystone and foundation species

Results

- Complex matrix table – 200 rows, 20 columns
- Some MSP indicators with no direct linkage to CR questions
- Some CR metrics with no comparable MSP indicators - human health considerations
- Attractive indicators with minimal or no data available - biodiversity, forage fish biomass, mean trophic level (in each habitat type)

Examples of Alignment

CR metrics	MSP indicators
Chlorophyll content	Chlorophyll-a quantities
Water temperature	Sea surface/water temperature
Hypoxia (frequency, extent, duration)	Hypoxia (portion of continental shelf impacted)
Biogenic habitats	Biogenic habitat map; aerial extent of kelp
Sea otters (keystone species)	Sea otter population size and condition (reproductive output)

Next Steps

- Continue SWG work?
  - Recommendations for keystone, foundation, and focal species
  - Revise and augment indicators/metrics to support next Condition Report
  - Prioritize indicators based on evaluation criteria in State report
- Evaluate OCNMS Science Needs: good indicator with no data = science need

National Marine Sanctuaries
National Oceanic and Atmospheric Administration

NATIONAL MARINE SANCTUARIES

OLYMPIC COAST